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Prepared for
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Truck & Coach Division
Pontiac, Michigan 48053

Mathematical Simulation of the Ground-Water Flow Conditions Under GM's Truck and Coach Division, Pontiac, Michigan

October 1981

EPA Region 5 Records Ctr.
345291

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October 20, 1981

Mr. Dan S. Harrett
Staff Engineer
GMC Truck & Coach Division
General Motors Corporation
660 South Blvd. East
Pontiac, Michigan 48053

Reference: Geohydrologic Study - P.O. TK000916

Dear Mr. Harrett:

Enclosed with this letter are three copies of our report on the geohydrologic study we performed for you at your main manufacturing complex.

The results of the study indicate a remote possibility for the off-site migration of any accidental loss of contaminants that may occur. Comparison of the analysis of GM well #6 with analyses of other GM wells, as well as from nearby subdivision wells, indicates a slight degree of water quality degradation due to sulfates and chlorides. These may have originated from GM operations, or from a nearby off-site illegal hazardous waste site. Location of the origin of this abnormality and its areal extent, as well as the determination of any local groundwater contaminants at individual locations of interest, would require the installation of monitoring wells specifically for this purpose.

We have tentatively planned to meet with you on Friday, October 30th, at 11:00 a.m., to discuss the findings of this study. If this date is not suitable, please let either Ross Overby or me know so that a new date may be made.

Very truly yours,

CAMP DRESSER & McKEE
A Partnership

Lloyd W. Curry

Lloyd W. Curry
Regional Manager
Industrial Division

LWC/ep

Enclosures

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1.0 Introduction

On Monday, August 28, 1981, CDM initiated an investigation of the groundwater system under and in the immediate vicinity of the General Motors Truck and Coach Division Plant in Pontiac, Michigan. This study was directed toward determining the ground-water flow directions and gradients induced by the utilization of a ground-water supply by GM and a nearby subdivision. Knowledge of ground-water flow directions is valuable in assisting in the preservation of the local and regional ground-water quality because most pollutants migrate in tandem with the groundwater. Additionally, CDM related the locations of potential ground-water pollution sources to the ground-water flow in the aquifer system to evaluate potential impact should containment of the materials ever fail.

Also, on the above date, CDM met with Mr. Dan Harrett at GM's Pontiac Plant to aquire and discuss the existing well and boring data and information concerning potential pollution point sources. Photocopies of the data were brought back to CDM's Milwaukee office for in-depth study. The well data consisted of logs from GM's active and discontinued water supply wells, test holes and the log from the north well servicing a subdivision located just south of the plant. Data for the south well servicing the subdivision was obtained over the phone from the Michigan Department of Health. Foundation borings were also reviewed for pertinent information. From the data, CDM was able to characterize the subsurface conditions, aquifer performance and important hydrologic factors which were utilized in a mathematical simulation of the effects on the groundwater system induced by GM's and the nearby subdivision's utilization of a groundwater supply. This report presents the results of the investigation. A glossary of hydrologic terms used in this report is contained in Appendix A.

2.0 Geologic Setting

The surficial materials under the Plant site are glacial deposits derived from the glacial periods concluding approximately 10,000 years ago. From the land surface down to an approximate depth of 150 feet, the materials are predominantly clay tills comprised of a mixture of clay, silt, sand, and gravel. Clay till generally has a low to very low permeability. Within the clay till numerous sand lenses and/or glacial outwash channels are found. These sand deposits are potentially low to moderate capacity aquifers, however, the data reviewed for this study indicated only one of the lenses is being used as a water supply. The largest sand lense identified was found in the vicinity of Well #7 located near Building 43 (See Figure 1). The depth to this sand lense is 119 feet and the lense is approximately 7 feet thick. The extent of this lense is unknown, but the geologic data available indicates that it is of limited extent. There is some confusion on the well log whether or not this lense is being utilized for a water supply. Contradictory statements are made as to the screening of this aquifer. However for the purpose of this study, it was assumed that this lense is being utilized. In the vicinity of Buildings 48, 28, and 47 (Figure 1), east of the existing coal pile and west of Parking Lot G, the clay till deposits entend to depths greater than 150 feet. Data from Test Hole Number 3, located near the southwest corner of Building 13 (Figure 1), indicate that the clay till in this area extends to a depth of 350 feet or more. This clay till "Block" has important hydrologic characteristics and effects which are discussed in Section 3.2 of this report. A moderately thin, 10 to 25 foot thick medium sand to fine sand aquifer is located at an approximate depth of 150 feet. This aquifer is somewhat extensive, excluding the clay "Block" area, and is utilized as a water supply by GM and the subdivision south of the Plant. Underlying this aquifer, from an approximate depth of 175 feet down to approximately 230 feet, is a depositional sequence of clay till which would not be considered an aquifer. Underlying this second clay till sequence from a depth of approximately 230 feet to approximately 270 feet is another aquifer comprised of medium coarse sand and gravel. This aquifer is also utilized as a water supply by GM and the subdivision. This is the lowest aquifer utilized by GM and it is underlain by clay of an undetermined thickness.

The ground-water levels under the Plant site are highly variable and probably represent perched water. Typical ground-water levels obtained from foundation borings with a typical depth of 30 feet range from zero feet near the eastern part of the Plant to depths of 6 to 10 feet.

The aquifers under the Plant site are considered confined aquifers due to the presence of the clay till overlying each water bearing unit. This clay most likely prevents a significant amount of water exchange between the aquifers and causes the water levels in the confined aquifers to differ from the groundwater table levels obtained from the foundation borings. Data indicates that the average potentiometric water levels (the static depth to water within each well) of the three aquifers are 68 feet below ground level. Actual potentiometric water levels for individual aquifers could not be determined from the existing data because many of the wells were screened in two of the aquifers. A few wells are screened exclusively in the 150 foot deep aquifer with resultant static water levels of 68 to 70 feet indicating that the lower 230 foot deep aquifer probably does not have a vastly different static water level. Cross-sections have been prepared and are presented in Appendix B of this report.

3.0 Hydrologic Evaluation

3.1 Determination of the Aquifer Parameters

The data obtained from GM was used to determine the following aquifer parameters: transmissivity, storage coefficient, and boundaries, which were input into a mathematical simulation of the two aquifers beneath the plant site.

To determine the aquifer parameters, the drilling logs were examined for aquifer type (sand, gravel, etc.), aquifer thickness, static water levels, and any aquifer testing data. Also those logs which indicated that no usable aquifer was present were noted.

From the well logs it was apparent that the aquifers underlying the plant are confined. Therefore, a storage coefficient of 1×10^{-4}, which lies within the average range for a confined aquifer (Freeze and Cherry, 1979) was assigned to these water bearing units. Available data does not allow the calculation of the actual storage coefficient.

The method used to determine the transmissivities was an approximation method developed by T.R. Hurr (Kruseman and DeRidder, 1976). This method was used because it provides an estimation of the aquifer transmissivity from a single drawdown observation measurement which was the only type of pumping data available from the drilling logs. The Hurr method requires that the drawdown used in the calculations be caused by the movement of water through the aquifer only excluding drawdowns caused by well inefficiencies or interference. Unfortunately all data was obtained from pumping wells and therefore includes some well loss (efficiency) components. Additionally, data from at least one pump test indicated that there is apparently some interference effects from other wells in the area. The limited data does not allow for the quantification of either the well losses or the interference caused by other wells; however, the relative magnitude of the transmissivity can be determined and was used to determine the flow field as proposed for this study.

The calculated transmissivities were cross checked by reviewing the well logs to determine if the transmissivity values calculated were reasonable for the types of materials in the aquifers and their thicknesses.

3.2 Determination of the Flow Field

The primary method used to determine the drawdown distribution is the "Principal of Superposition". This principal states that the drawdown at any point in an aquifer is equal to the arithmetic sum of the drawdown caused at that point by each individual well in the aquifer (Walton, 1970).

The till "block" as previously discussed acts as a hydrogeologic barrier, in that the extremely low permeability of the till, especially in relation to the aquifers, effectively prevents the movement of water across this area. The inability to draw water from this area increases the influence of pumping in directions where water is available.

To simulate the effect of the till "block" on the flow field, the image well theory was used. This theory states that a hydrogeologic barrier can be simulated by placing an imaginary pumping well opposite the pumping well and equidistant from the boundary (Walton, 1970). This theory assumes that the boundaries extend to infinity in both directions.

The pumping rates used for the sumulations were determined by examining the water use data and averaging this over the selected pumping time to obtain a constant pumping rate. A pumping time of one year was used to simulate the long term pumpage of the wells.

For the simulations, the plant site was considered to be underlain by two aquifers which are separated in the horizontal plane by the till "block", and form an upper and lower aquifer in the vertical plane.

The upper aquifer lies north and west of the till "block" and is tapped by GM wells #6 and #3.

The lower aquifer lies south and east of the till "block" and is tapped by GM well #7 and the subdivision wells. This aquifer actually consists of two aquifers separated by a layer of clay till. However, the wells are screened in both and therefore they are considered to act as a single aquifer for this simulation.

3.3 Results of the Mathematic Simulation of the Upper Aquifer

The upper aquifer is separated from the subdivision wells by the till "block" which is located south of GM well #6. Also the only wells screened in this aquifer are GM #6 and GM #3. The information obtained from GM indicates that Well #3 is pumped very intermittently. Therefore, for this simulation, only the effects of well #6 were considered.

The parameters used for this simulation were as follows:

- Pumping rate for well #6: 150 gpm for 1 year
- Transmissivity: 50,000 gpd/ft
- Storage coefficient: 10^{-4}
- One boundary running ENE - WSW and lying approximately 900 feet south of well #6 (Figure 2).

The results of the simulation indicate that the groundwater flow is basically radial with the till block giving the flow pattern a semi-circular configuration with no appreciable flow coming from the south toward well #6 (Figure 2). When well #3 is pumped, the drawdown effects in this aquifer would be increased probably increasing the drawdown influence beyond the limits induced by well #6 alone.

3.4 Results of the Mathematical Simulation of the Lower Aquifer

The lower aquifer is tapped by both subdivision wells and GM well #7. Therefore the simulation of this aquifer included the subdivision wells #1 and #2 and GM well #7. The parameters used for this simulation were as follows:

- Pumping rates: GM #7 = 150 gpm, subdivision #2 = 75 gpm, subdivision #1 = 25 gpm
- Transmissivity: 100,000 gpd/ft
- Storage coefficient: 10^{-4}
- One Boundary running NE - SW and lying approximately 500 feet Northwest of well #7 (Figure 3)

The results of this simulation indicate that at some distance from GM #7 the flow is radial toward well #7 with a semicircular pattern similar to that discussed for the upper aquifer. The subdivision well #1 is too far away and pumps at too low of a rate to have much influence on the flow pattern under the plant. However the subdivision well #2 has significant effect on the flow pattern.

The effect of well #2 is that some of the flow from the south central part of the study area is diverted toward this well instead of moving toward well #7 (Figure 3).

This "area of capture" can be defined by a wide parabola which opens downward and has its apex approximately 300 feet north of subdivision well #2. The water, and any contaminants in it, which is inside this parabola will tend to move toward subdivision well #2 and not GM well #7. The water outside this parabola will tend to move toward GM well #7 and not toward the subdivision well #2.

The area of capture as shown on Figure 3 relates to the parameters used in this particular simulation and will shift position depending on the actual pumping rates of the production wells. However if the ratio of the pumping rates is kept constant, the position of the dividing line will not change significantly.

3.5 Simulation Limitations

The till "block" which is being simulated apparently terminates under the GM plant. Therefore, the flow field as shown in the northeast portion of Figures 2 and 3 would differ somewhat from the actual flow in this area. The differences are that the actual drawdown would be less than the calculated drawdown in this region and that some movement of groundwater would occur from the northern portion of the aquifer around the tip of the till block. It should also be noted that deep test drilling is not areally extensive and thus the existence of other boundaries or the actual extent of the till block is limited.

4.0 Potential Point Source Contamination

During our meeting with GM potential point sources of contamination were identified.

The types of point sources identified are:

- Tanks (fuel, oil, etc.)
- Coal storage area
- Former coal storage area
- Waste management area
- Gasoline island
- Plating areas

The location of each potential source is indicated on Figure 1. Should any of the potential pollution sources leak or produce a leachate, the resultant pollution would migrate downward into the groundwater system. The first area affected would be in the immediate vicinity of the source. As indicated previously, the upper 100-150 feet of subsurface materials is comprised of clay till with sand lenses or interbeds. The pollutant would probably continue to migrate downward and if any sand lenses were encountered the pollutant could possibly migrate laterally away from the point source. This occurrence is dependent on localized groundwater flow directions and head differences. Determining the localized groundwater flow directions in this complex geology is not cost effective and should be conducted on a case by case basis. Over time the pollution may possibly continue to migrate downward and could enter the aquifer system described previously. As this study indicates, should such a situation occur, the contaminants should be drawn into General Motors' water supply wells.

5.0 Existing Groundwater Quality

Groundwater quality records were reviewed by CDM and there is very little difference between the quality of water obtained from GM's wells and water obtained from the subdivision wells. One exception to this is that sulfates and chlorides are higher in GM's well #6. The concentration of these substances is approximately two to three fold greater than determined in the other wells but is still below EPA standards for potable water. The source of the sulfate and chloride could not be determined within the scope of this project. The source may be background isolated from the other wells by the till "block" or may represent operations in the vicinity of well #6.

6.0 Conclusions

In evaluating the directions of groundwater movement in the vicinity of the GM plant site, assumptions had to be made based on the limited data available. Therefore the conclusions which follow should be viewed as qualitative and not quantitative in nature. To determine the actual drawdown and flow field would require an extensive and expensive test drilling and observation well installation program. The purpose of this project was to determine if such a program was required.

The conclusions based on the mathematical simulation of the aquifer in the vicinity of the plant site are as follow:

- Beneath the plant site the flow of groundwater in the primary aquifer system is radially inward toward GM wells #6 and #7. Therefore the potential for contaminant movement off the plant site via the main aquifers is low.

- Specifically the potential for contaminant movement to the subdivision wells is low and will remain low provided that the water use from the GM wells continues to be much greater than that of the subdivision wells.
- There appears to be no degradation of the groundwater quality in the aquifer system at the present time.

7.0 Recommendations

Except for a possible situation at GM's well #6, there appears to be no ground-water pollution problem in the aquifer system in the vicinity of GM's Pontiac Plant. However, General Motors may wish to consider initiating a small scale groundwater monitoring program focused on shallow deposits near critical potential point sources. One such source is the waste management area. A small scale monitoring program would consist of the installation of approximately four, two-inch diameter wels to approximate depths of 25 to 30 feet around each point source of concern. Quarterly monitoring of these wells would indicate any unusual occurrences or problems while such circumstances are still manageable.

8.0 References

Freeze, R.A., and Cherry, J.A. 1979. "Groundwater." Prentice-Hall. englewood Cliffs, New Jersey.

Krugeman, G.R. and Deridder, N.A. 1976. "Analysis and Evaluation of Pumping Test Data". International Institute for Land Reclamation and Improvement. bulletin II. Wageningen, Netherlands.

Walton, W.C. 1960. "Groundwater Resource Evaluation". McGraw-Hill. New York.

Appendix A

GLOSSARY OF HYDROLOGIC TERMS

Aquifer — An aquifer is a formation or group of formations that can yield water in sufficient, useable quantities

Confining Bed — A confining bed is a unit of material which does not freely transmit water usually because of very small pore spaces. Clay is a confining bed

Drawdown — Drawdown is the lowering of the water level caused by pumping

Permeability — This term is used to define a materials ability to transmit water. It is usually expressed in gallons per day per square foot of aquifer. A material with a high permeability transmits water easily.

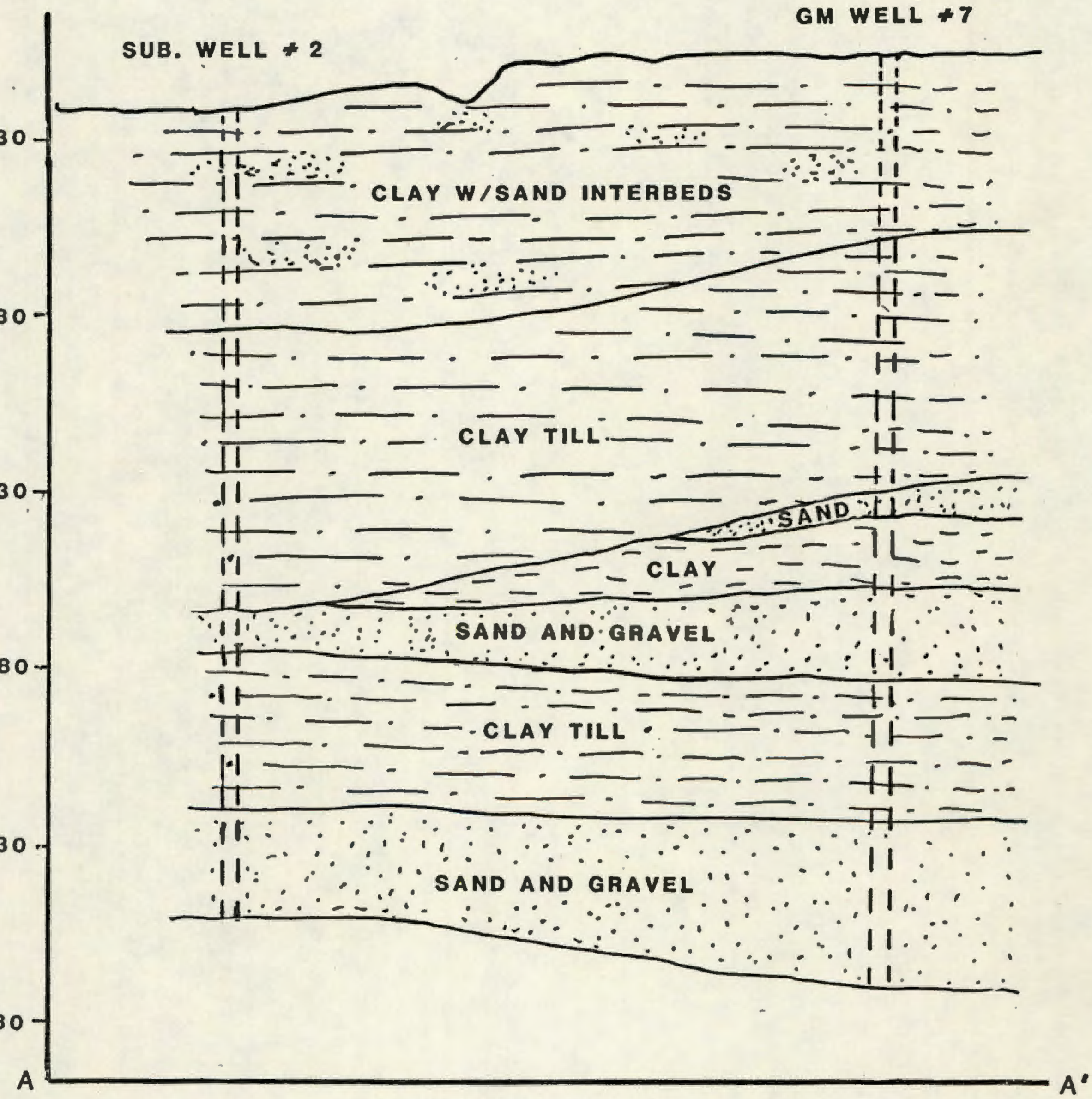
Porosity — Porosity is a measure of a materials pore space. If a cubic foot of sand was drained of all its water and the water volume was found to be 1/4 of a cubic foot, the porosity of the sand would be 25%. Materials which are composed of generally the same size particles have a high porosity. A great variation in particle size decreases the porosity because small particles fill in the pores made by larger particles.

Specific Capacity — The specific capacity of a well is a measure of how much water can be pumped per minute for every one foot of drawdown.

Storage Coefficient — This term is unitless and defines the amount of water that is taken into or released from storage per cubic foot of aquifer. In an open aquifer with no confining bed the amount of water that can be stored or released per cubic foot is equal to the pore space (porosity). In aquifers with a confining bed the storage coefficient is dependent upon the compression of the water (water is partially compressable) and the compression of the aquifer. Through countless investigations and correlations made by hydrologists it has been determined that the storage coefficient of confined aquifers ranges from .001 to .00001 dependent upon the compressability of the aquifer.

Transmissivity — Transmissivity is the rate at which water is transmitted through the thickness of the aquifer. The number is arrived at by multiplying the permeability of the aquifer by the aquifer thickness.

Appendix B



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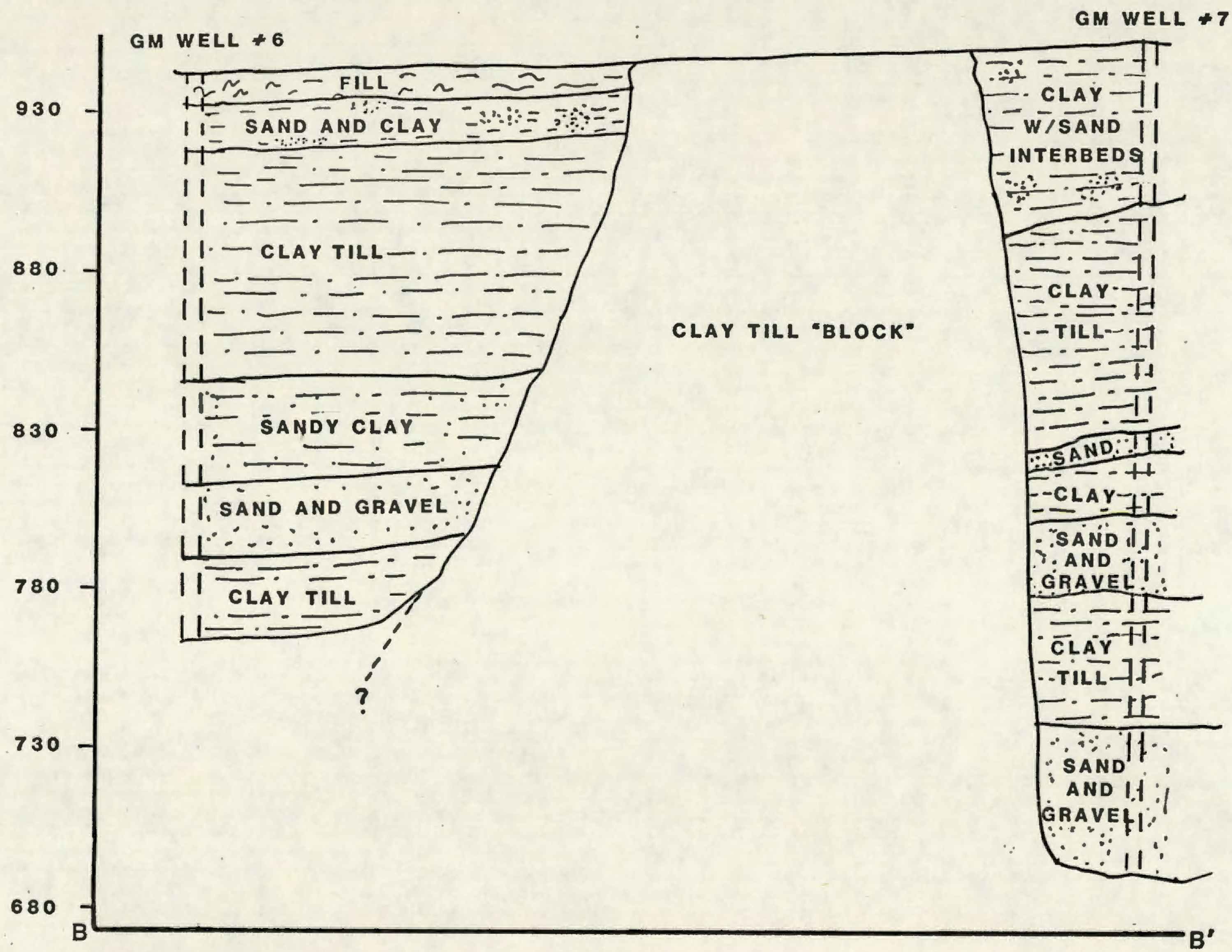
VERTICAL SCALE 1":50'

VERTICAL EXAGGERATION 8X

CROSS- SECTION A-A'



VERTICAL SCALE 1":50'

HORIZONTAL SCALE 1":400'

VERTICAL EXAGGERATION 8X

CROSS-SECTION B-B'